# How to Make, Connect and Operate a Practical Radio Telephone Receiving Set

By WILLIAM G. H. FINCH,
Associate Member Institute of Radio Engineers.
Written for International News Service.

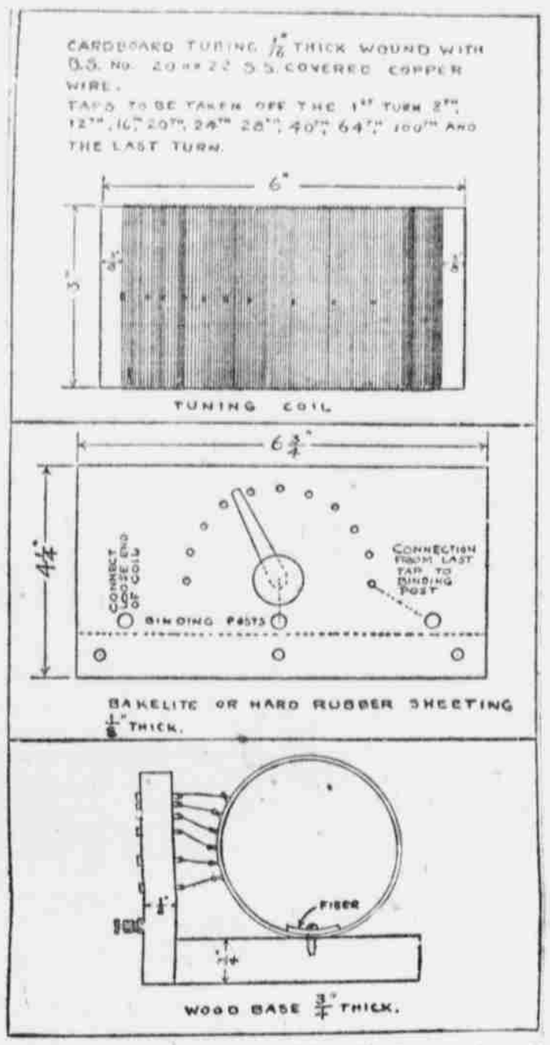
A simple radio receiver suitable to receive the radiophone broadcasting and telegraph signals of the following items, which will be treated separately.

1. An inductance or tuning coil by means of which the wave length of your set may be tuned to that of the station you desire to receive.

2. Crystal rectifier or mineral detector that will enable you to receive or make audible the electro magnetic wave carrying voice or telegraph signals in your telephone receiver.

3. High resistance telephone receiver, the use of which enables you to hear the weak current rectified by the detector.

4. Fixed condenser, same for receiving




receiver that stores up the weak currents and then discharges them through the telephone receiver.

**Aerial Is Essential.**

5. Antenna, or aerial—A wire or wires suspended in the air and insulated from all surrounding objects being a part of the electrical system by which the electro-magnetic waves are sent or received.

6. Ground—May be a wire buried in the earth or an artificial ground may be a waterpipe which completes the radio circuit.

The first item to consider is the tuning inductance or tuning coil. One that will give good results may be constructed as follows:

Materials needed—One card-board tube 1-16 of an inch thick, 3 inches in diameter, 6 inches long; 1-5 pound of No. 20 or 22 B. S. single silk-covered copper wire, one 1½ inch radio switch lever and hard-rubber knob, 12 switch points, one wood base three-fourths of an inch thick, 6¾ inches long, 4 inches wide; one sheet of bakelite 6¾ inches long, 4½ inches wide, one-eighth inch thick, and drilled as shown; three nickel-plated binding posts; four wood screws to secure bakelite front to base as shown.

**How to Start It.**

After you have secured the above materials and with the aid of a screw driver, paint brush hand drills and some orange shellac, take cardboard tube, give it a good coat of shellac, after it is dry punch small holes three-eighths of an inch from either end with a darning needle; pass wire through and tie single pass wire through and tie around about one foot to make connections. Wind eight turns, scrape a small amount of the insulation off and solder same into circuit for tap. (Note—Use about six feet of wire and cut same into 11 equal lengths to use for taking taps off of the coil.) Be sure when taking taps from the coil that connections are tight, soldered and taped. Take taps off 8th, 12th, 16th, 20th, 24th, 40th, 64th, 100th and last turn. Be sure you have all connections soldered and taped, because you are working with very weak currents and cannot afford to let any leaky conditions exist.

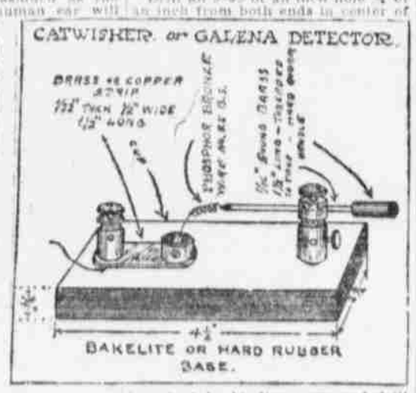
After you have the above work done shellac the windings, as this will help keep them in place and at the same time help keep the moisture away, thus warding off grounds. Take some hard rubber or bakelite sheeting and drill to take switch points, binding post and switch lever as shown in the drawing. Drill also three holes to take one-eighth inch wood screws as shown to secure bakelite front. Connect and solder taps, starting from the left, as illustrated. Secure coil to base with fiber strip and make connections as shown.

---

When a radio message is sent it travels as fast as light, 186,000 miles per second, the current having a frequency as high as 100,000 cycles per second, and, inasmuch as the diaphragm of the human ear will not respond to frequencies or vibrations over 20,000 per second it is evident that some means must be found to detect and translate these impulses before they reach the telephone receiver. It is a known fact that certain crystals possess the necessary properties to accomplish this result, the most popular one used being galena, contact being made by a fine springed wire — hence the name "Catwisker." In order to construct this type of Catwisker galena detector it will be necessary to obtain the following materials:

1 binding post.
1 double binding post.
1 bakelite or hard rubber base 4½ inches long, 2½ inches wide, ¾ inch thick.
1 piece of galena mounted on cup obtained from any radio supply store for 35 cents.
1 brass or copper strip.
2 inches of phosphor bronze or copper wire, No. 28 or 30 B. S. gauge.
1 round brass rod 1-16 of an inch or 3-32 of an inch in diameter, 1½ inches long, threaded to take hard rubber handle.

Drill an 8-32 of an inch hole ¾ of an inch from both ends in center of base to take binding posts and drill another 8-32 inch hole 1¼ inches from edge on left side to take crystal cup and take the copper or brass strip, square up and mark off. To mount detector cup and binding post after the three holes are drilled, mount the binding post and metal strip as illustrated. Make a spring out of the phosphor bronze or copper wire as shown, soldering same to the end of the rod. You will now have completed the detector.




Without the telephone receiver you would be without means of hearing the many radio telephone concerts that are broadcasted and which have been the contributing cause in converting the general public to this instructive and most fascinating art—radio telephony.

It has been established by the pioneer radio engineer that the usual telephone receiver, such as is used on your desk telephone, was unsatisfactory for radio purposes. It was not until after considerable research and experimental work that a type suitable for radio purposes was developed (see Fig. 1).

In order to thoroughly understand the theory and operation of this wonderful little instrument one would have to have a good schooling in magnetism and elementary electricity, and the writer will attempt to give only a brief outline of what takes place in the receiver.

Refer to Fig. 1.—This style of receiver is known as the watch case type and the reason for adapting same was due to it being small, permitting it to be worn on the head by the operator. It is a general practice to wear a pair mounted on a headband, and by so doing keeping out most foreign and unwelcome sounds.

The principal reason why the usual telephone receiver is not adaptable for radio work is because it is of low resistance winding (a standard being 75 ohms) and is constructed so as to give a loud sound, requiring many times more current which can be easily applied in the usual wire telephone circuit, which is not the case in radio, the rectified radio telephone or telegraph currents being many times smaller, therefore requiring a much more sensitive receiver, and to obtain this it was necessary to improve upon the magnets and increase the windings on the electromagnets from 1,000 to 2,000 ohms on each receiver in order to obtain a greater number of ampere turns. As an illustration:

An electromagnet having 10 turns, by passing one ampere through this winding you will have 10 ampere turns. By passing through the same winding 20 amperes you will then have 200 ampere turns—on the other hand, if you increase the turns to 2,000 and pass one ampere through you will then have 2,000 ampere turns, which will give you greater magnetic pull—thereby making the receiver more sensitive.

The receiver acts as a translator to the voice or music currents and converts them to sound waves (with some distortion) as follows:

**How Receiver Acts.**

The voice or music is impressed by a microphone on the electric currents at the sending station and is rectified by the detector at the receiving station, then passing through the winding of the receiver (Fig. 2), thereby energizing the electro magnetics and causing the diaphragm to vibrate (attracted and repelled), accurately reproducing the vibrations as recorded by the microphone at the transmitting station. The fluctuating vibrations of the diaphragm produce the corresponding sound waves, thus making the voice audible. (See Fig. 2.)

The usual telephone receiver is wound with B. S. gauge No. 34 or 36 and the standard radio receiver with much smaller wire, being B. S. gauge No. 44 to 48 for a 1,000 to 2,000-ohm receiver.

The writer does not recommend that any of the readers attempt to rewind receivers, one of the greatest difficulties encountered being that of breaking the wire, which is as fine as the human hair, and even though you should succeed, a rewound receiver does not give anywhere near the satisfaction or compare with a properly designed radio receiver.

There are a number of receivers of good make on the market. A good pair can be purchased from any of the radio dealers for $5.50.

The action that results from applying a current to two or more conducting surfaces same being separated by a dielectric (mica sheets, glass or paraffin paper) (see Fig. 1) is employed in many ways in radio circuits. Such a device is called a condenser, and is said to have a certain capacity or so many microfarads, depending upon the number and size of the conducting surfaces and the dielectric separating them. This may be of a fixed or variable capacity, depending upon the construction. If the elements are stationary, it will be of a fixed capacity, and if they can be moved at will it will be of a variable capacity.

Since ours is a single circuit receiver employing a crystal detector or rectifier, it will be of help to employ a condenser of small capacity across telephone receivers which will have the effect of taking the weak electric impulses which after being rectified by the detector are of an intermittent direct current nature and storing them up in the condenser. After same is fully charged it discharges them in a more even manner in the telephone receivers, which will have the effect of increasing the signal audibility which is always desirable.

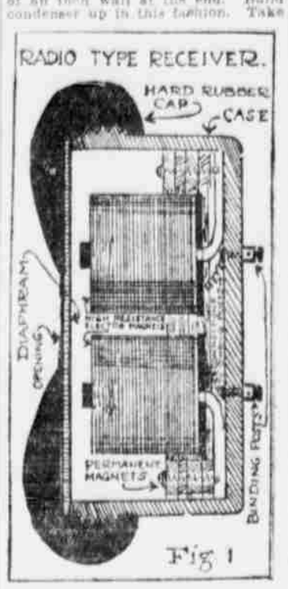
This piece of apparatus is very simple and easy to construct, but care must be taken to smooth out the tinfoil to avoid blisters and see that all sheets of foil are uniform.

**Following Materials Needed.**

A condenser for our purpose should have a capacity of about .002 microfarads and the following materials will be needed:

2 binding posts.
1 hard-rubber base ¼ of an inch thick, ¾ of an inch wide, 2½ inches long.
1 hard-rubber cover ⅛ of an inch thick, 1⅛ inches long, ¾ of an inch wide.
7 sheets of tinfoil ½-inch wide, 1½-inches long (which can be purchased from a florist).
7 sheets of mica ¾ of an inch wide, 1 inch long, .002 thick.

To construct, drill four 8-32 inch holes in the hard-rubber base as shown in figure 2. Now take the tinfoil strips and in one end punch holes to take the binding post machine screws allowing about 1-16 of an inch wall at the end. Build condenser up in this fashion. Take




the two binding post machine screws and mount them in base as shown. Take a piece of mica sheeting and place it ¼ of an inch from either end. Now take a piece of tinfoil, passing machine screw through the hole on the right. Now take another piece of mica sheeting, placing it directly over the preceding one. Then take a piece of tinfoil and place it over the machine screw on the left end and follow these operations until you have used the seven sheets of tinfoil and mica sheeting. You will see by this arrangement that you have alternated the tinfoil strips each time. You will then have three strips of tinfoil connected with the binding post on the left side and four on the right, and will end by having a piece of mica on top of the last tinfoil strip. Now take the cover and drill two holes to take binding post machine screws, and assemble as shown in figure 3. Tighten up on the binding posts so as to compress the tinfoil and mica sheeting, thereby increasing the efficiency of the condenser.

---

Now we come to one of the most important items that enter into the success of any radio station—the aerial, or antenna (means for absorbing or radiating electric magnetic waves, as used in a radio telegraph or telephone).

As mentioned in one of the previous articles, an aerial or antenna is a conductor supported in the air and insulated from all surrounding objects. There are many types of aerials, such as the flat-top "T" type, Fig. 1, inverted "L" type, Fig. 2; umbrella type, Fig. 3. However, most of these types are made up of a plurality of wires (four or six wires, or even more). These types of aerials are used mostly for transmitting purposes, but for receiving purposes only a single wire, suspended in the air and insulated from all surrounding objects, will serve our purpose well. To obtain the best results with this set it would be advisable, where it is possible, to have an aerial from 100 to 150 feet in length and 30 or 40 feet high at both ends.

The necessary materials are:

One hundred and fifty feet, or more, of No. 12 or 14 B. and S. gauge bare copper wire.

Two to four insulators, depending upon the conditions that must be met.

One porcelain tube.

**How to Make Aerial.**

The drawings are self-explanatory, and with a little advice you will be able to construct your aerial so as to obtain successful results.

First. Always bear in mind that the effectiveness of your aerial and the success that you will derive from your set depend mostly upon how effectively you have insulated your aerial. Spare no pains to do this job right.

Second. Avoid "kinks," turns, twists in your aerial and lead-in wire.

Third. The aerial or antenna wire can be put through the hole at one end of the insulator and the stay-wire through the other. A lead-in wire can be fastened to any part of the aerial or antenna, or simply brought off as an extension of the main wire. Where the wire runs around a corner of the building, or under similar circumstances, an insulator can be fastened by means of a large screw to a wooden supporting stick. Then the lead can be put through or fastened to the hole at the extended end of the insulator.

Fourth. If due to conditions you must cut your wire, be sure that when you make the connection it is soldered.

Fifth. If a support can only be found for one end the wire can be run from the house to a short pole 25 or 20 feet high near by. On apartment house roofs, chimneys, pipes and other objects offer good natural supports.

---

It is well known that the earth is a conductor of electricity and is therefore used extensively in nearly all kinds of electrical work, especially that pertaining to signalling. And it has been the means of saving a great amount of money that would otherwise have been spent for wire.

A good ground and ground connection are of the greatest importance entering into the successful operation of any radio station. The distance a station may transmit or receive is often determined by how efficient its ground system is.

In cities and towns a good ground connection may be made with the water and steam pipes. The best means for making this connection is by the use of a standard ground clamp (Fig. 1), which may be purchased from an electrical or radio supply store for not over 15 cents.

When making use of the water pipe in the house it is advisable and common practice to short circuit the water meter, as shown in Fig. 2, by means of a heavy copper wire. Should there happen to be other pipes in the vicinity of the water pipe to which you are making ground connections it would be advisable to connect them all, for this would increase the efficiency of your ground.

It is not so convenient for our farmer cousin to make ground connections. A good ground may be obtained by taking an old wash-boiler and soldering the ground wire to one of the handles or sides and sink it in a river, creek, lake or a discarded well. If none of these facilities are available and you have a cistern or pump solder the wire to the iron pipe.

A fairly good ground may be obtained by burying some metal sheets, preferably copper, about 10 or 12 feet below the surface of the earth. It is general practice to bury a layer of charcoal or coke, placing the metal sheets on top then putting another layer of charcoal or coke on top of the sheets. This insures a good connection between the earth and buried sheets at all times. Another good way is to drive three or four iron pipes 8 feet into the earth and solder the ground wire to them.

Generally speaking, aerials do not attract lightning, but they do pick up atmospherical electricity and, of course, this condition does create a hazard. However, when the aerial is properly grounded it will also act as a lightning rod and thereby protects the property from electrical hazard.

Briefly, the fire underwriters require that the aerial must be grounded when not in use by a copper wire not smaller than B. S. Gauge No. 14 or larger, and run said wire as directly as possible to the outside. (Note—This means that gas or steam pipes that are properly cannot be used for a lightning ground, because if ever the building was called into service there is a possibility that fire and loss of life may result. So do not use these grounds for lightning arrestors.)

Fig. 3 shows the proper method of ground aerial for lightning protection. The fire underwriters require that no smaller than a 250-volt, 100-ampere single pole, single throw knife switch be used. The correct way for connecting the switch is shown in Fig. 3. The aerial lead-in wire is connected to the middle terminal of the switch, the wire leading to the instrument is connected to the upper terminal, while the ground wire will be connected to the lower terminal and run as directly as possible to the earth. (Switch to be outside of the building.)